# Affordances of Virtual Touch Button in User-Computer Interaction

Li-Hao Chen*, Pei-Jung Cheng**

** Department of Applied Arts, Fu Jen Catholic University, Taiwan, ahao55@gmail.com*
*** Department of Media Design, Tatung University, Taiwan, admufy@gmail.com*

Abstract: The aim of this study is to find out the affordances presented by the virtual touch buttons through exploring the relation between users' intuitive operation behaviors and the features of the touch buttons. This study recorded the thirty subjects' first touch traces on the touch button for the task and counted the times of operation behaviors within the thirty subjects. The results show that the subjects' operation behaviors on the touch buttons mainly present two kinds of actions, pressing and sliding; different features of virtual touch button present different affordances for users, which influence users' operation behaviors in user-product interaction.

***Key words: Affordance, User-Computer Interaction, Intuitive Interaction***

## 1. Introduction

Product functions have become more complex as technology progress. Product designers are often asked to create consistently appealing and unique product forms to satisfy the various demands of customers [1]. In addition to the aesthetic perception of product forms, the usability of products as one of significant user demands should be deeply considered in product design. In user-product interaction, the parts of a product are particular important because users generally act directly upon them [2]. As we know, most of consumer electronic products generally have the interfaces with virtual icons as the product parts that facilitate users to directly interact with the complex product functions. In recent years, the term intuitive interaction has been paid more attention in user-product interaction. Designing intuitive interaction suggests utilizing prior knowledge through user experiences to make the subconscious-fast uses [3, 4]. Affordance concept proposed by Gibson [5] as the one of promising theories describing subconscious processing phenomena stems from psychology [3] which has been applied to all sorts of user interface issues [6]. However, affordance is not totally mature in design [7] and it still has various manifestations in current design practice.

Affordance in design presents different expositions through literature review, which include: the relation between perceivers' actions and features of objects [8, 9, 10, 11, 12]; -abilities of objects [13, 14, 15, 16] and being determined by users' cultures [6, 17, 18, 19, 20]. The physical-behavioral relation between users and objects as Norman's real affordance [21] easily gives example: plates can be pushed by hands; knobs can be turned by fingers. This perspective of affordance seems to have limitations on application of design practice and could not completely explain how it works on user-product interaction. For this reason, the related studies have extended affordance concept as being relative to users' cultures. That is, the meanings of objects must be created internally and mentally by the users. For example, as Silver [22] notes, people have learned most of the conventions: buttons are for pushing, knobs are for turning, switches are for flicking, and strings are for pulling. As the term perceived affordance proposed by Norman [21], which means perceiving affordances is based on users' cultures and

experiences. Besides the physical features of objects, the virtual object like an icon button is the important part of interfaces that presents perceived affordances [4] to effectively communicate a product's functionality to users.

Conceptualizing affordance as the abilities of object could get rid of the indistinct explication about affordance referring to physical features of objects or users' cultures. Thus, it also has benefit for designers to consider the general properties of products [13]. In user-product interaction, the abilities of product can be classified as moving in two applications, functionality and operability [16]. The operability refers to physical-behavioral possibilities in user-product interaction, such as grasp-ability, push-ability, assembly-ability, and so forth. The intended function as functionality of a product can provide users to satisfy particular goal, such as a mobile phone affords the functionality of making a call or sending messages to people in a social community. Perception of affordance refers to perceive information of object [10, 18, 20, 23]. The physical properties, appearance features, size and material as the information can present the product part's affordances operability; the artificial icons, signs or texts as the information are effective ways to specify a product's affordance for functionality. Thus, designers should purposely create appropriate information to effectively present the affordances for user-product interaction. In user-computer interaction, users might often act upon the virtual buttons. The features of virtual buttons conceivably influence users' physical-behavioral actions on the buttons. Thus, the aim of this study is to explore what affordances for operability the virtual buttons present to users in user-computer interaction; and the relation between the features of virtual button and users' operation behaviors.

## 2. Method

In order to explore what affordances the virtual touch buttons present to users, this study gathered the subjects' intuitive operation behaviors to the virtual buttons through a programmed test interface set in this study. Due to an object can have various affordance [24] and what affordances are perceived by users that influence their behaviors depends on these perceivers' current psychological states at the moment [25], a specific task was set in this study to standardize every single subject's action to the touch buttons as the identical goal-directed operation behavior. This study collected nineteen different types of touch buttons as the test samples and they can be mainly classified into four categories (see Table 1), circle with points (CP), circle with square (CS), circle with lines (CL) and circle with curves (CC). Category CP includes five features; CS includes four features; CL includes four features and CC includes three features. The test samples were separately arranged on an interface set in this study as the test interface (see Figure 1).


Figure 1. The test interface

## 2.1 Procedure

The test interface was programmed to record the subjects' operation behaviors on the test samples and it was presented on a touch screen. The nineteen test samples were singly and randomly presented on the test interface. The participants sat in front of the touch screen and then they were asked to complete the task set in this study as soon as possible by touching the nineteen test samples with their fingers. That is, the subjects had to separately operate the nineteen test samples to complete the task. The programmed interface simply recorded the subjects' first touch traces on the touch screen. The touch trace as the users' intuitive operation behaviors can be regarded as the affordances for operability of the virtual touch buttons that present to users. Moreover, the subjects' operation processes for the task were videoed. By comparing the touch traces on the touch screen and the data from the observations, the subjects' actual operation behaviors could be clearly found out.

## 2.2 Task and Subjects

Thirty subjects participated in this study (mean age=24.0, SD=3.9) and included twelve males and eighteen females who have had experiences using consumer electronic products. The task set up in this study is to touch the test samples on the touch screen with fingers to move the selected icon from left-up icon to right-bottom icon.

Table 1. The test samples

| Type | a | b | c | d | e | f | g |
|---|---|---|---|---|---|---|---|
| CP |  |  |  |  |  | | |
| CS |  |  |  |  | | | |
| CL |  |  |  |  |  |  |  |
| CC |  |  |  | | | | |

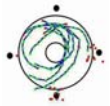
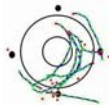
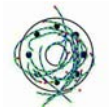
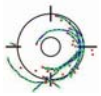
## 3. Results

Table 2 shows the subjects' touch traces on the test samples and the sum of operation behaviors within the thirty subjects. Analyzing the data from the observations, the subjects' operation behaviors on the test samples can mainly present two kinds of actions, pressing and sliding. Figure 2 shows the directions for the affordances presented by each test sample.

Overall, in terms of the sum of the subject's first operation behaviors on the test samples, the results show that most of test samples, twelve nineteenth, tend to present affordance for press-ability; the six test samples, CPe, CSa, CSd, CLc, CLg and CCc, tend to present affordance for slide-ability; test sample CSb presents half-and-half affordances for press-ability and slide-ability in user-computer interaction. For samples CPa, CPb, CPc, CSc, CLa, CLd, CLe and CCb, they clearly present the affordance for press-ability in user-computer interaction. As Figure 2 shows, samples CPd, CPe, CSa, CSb, CSd, CLb, CLc, CLf, CLg, CCa and CCc present the indistinct directions of affordances within the thirty subjects. In the test samples of indistinct affordances above, CPe, CSa, CSd, CLc,

CLg and CCc seem to present indefinite directions of affordance for slide-ability despite their sums of sliding are more than pressing.

Table 2. The subjects' touch traces and times for operation behaviors

| Samples | | Pressing | Sliding | Samples | | Pressing | Sliding |
|---|---|---|---|---|---|---|---|
| CPa |  | 21 | 9 | CLb |  | 16 | 14 |
| CPb |  | 21 | 9 | CLc |  | 14 | 16 |
| CPc |  | 22 | 8 | CLd |  | 26 | 4 |
| CPd |  | 18 | 12 | CLe |  | 20 | 10 |
| CPe |  | 12 | 18 | CLf |  | 17 | 13 |
| CSa |  | 12 | 18 | CLg |  | 14 | 16 |
| CSb |  | 15 | 15 | CCa |  | 18 | 12 |
| CSc |  | 19 | 11 | CCb |  | 20 | 10 |
| CSd |  | 14 | 16 | CCc |  | 13 | 17 |
| CLa |  | 24 | 6 | | | | |

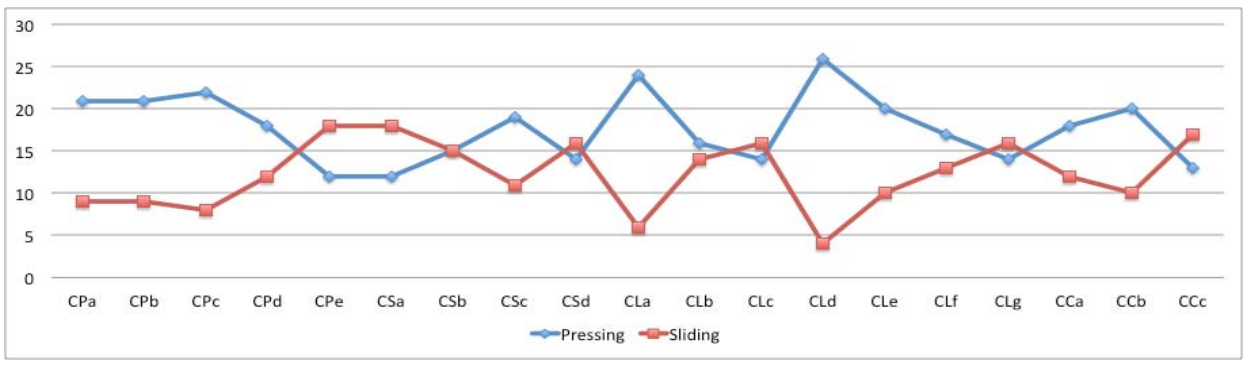



Figure 2. Directions for each test sample's affordances

## 4. Discussions

As the results show, samples CPa, CPb, CPc, CSc, CLa, CLd, CLe and CCb clearly present affordance for press-ability in user-computer interaction. For CPa, CPc, CPc, CLa, CLd and CCb, the features of points and lines with vertical-horizontal direction as the information for affordance suggest users to press on them. However, CPd in category CP cannot present clear affordance for press-ability even though it alike has the feature of points with vertical-horizontal direction that. The reason might be CPd's feature of concentric circles suggests that users can slide on it for the task. For category CS, unless CSc, the results show that the directions of affordances are hard to explicitly determined. In users' experiences, category CS is not the common features for virtual touch button on the interfaces of consumer electronic products.

For samples CLb, CLe and CCa, their features of four lines with forty-five degree angle present different directions of affordances (see Figure 3). The four lines in the samples are designed as different layouts that are common for users. Therefore, the similar features with different layouts could present different affordance perception in user-computer interaction. The relation between affordance perception and the three touch buttons' layouts is worthy of further study. For samples CPe, CLf and CLg, the features of eight points and lines with thirty-degree angle indistinctly present affordance for press-ability or slide-ability for users. The angles and numbers of the points and lines very likely suggest users both affordances of press-ability and slide-ability.


Figure 3. Test samples

## 5. Conclusions

This study recorded the subjects' touch traces and operation behaviors on the virtual touch buttons to explore the affordances presented by the virtual buttons and relation between their features and users' operation behaviors. The results show that different features of virtual touch button offer different perception of affordance for users, which influence users' operation behaviors in user-product interaction. The results of this study would be contributive for designing and improving user-computer interaction as design references. This study investigated thirty subjects' operation behaviors on the virtual touch buttons. More numbers of subjects would be worthily invited for further studies, and thus it might show different results in directions of affordance. In addition, the subjects' touch traces recorded in this study only offer the references for analyzing the operation behaviors. The positions of the touch traces on the touch buttons are worth to further analyze for exploring the touch buttons' usability.

## Acknowledgements

Financial support of this research by National Science Council, Taiwan, under the grant NSC101-2401-H-030-076 is gratefully acknowledged.

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